

FLEA EXCHANGE BETWEEN DEER MICE AND SOME ASSOCIATED SMALL MAMMALS IN WESTERN UTAH

Harold J. Egoscue¹

ABSTRACT.— Fleas obtained from deer mice and each of three sympatric rodents collected at the same times and places are quantified. When deer mice and canyon mice were caught together, 18.9 percent of the infested deer mice had canyon mouse fleas while 20.8 percent of infested canyon mice carried deer mouse fleas; long-tailed vole fleas were collected from only 3.9 percent of the deer mice but 67 percent of the voles associated with deer mice had fleas normally found on the latter; reciprocity was lowest between deer mice and desert wood rats, with three wood rat fleas found among 155 fleas collected from 33 deer mice, and 12 deer mouse fleas among 403 fleas found on 52 wood rats. Rodent nesting habits, particularly the willingness of deer mice to den in a wide variety of situations, is thought responsible for many stray associations. The long-term evolutionary effect of flea dependency on wood rat denning habits is briefly discussed.

The occurrence of host-specific fleas on other than their normal hosts has certain implications and usually suggests that the hosts have opportunities for direct contact or that the hosts share or make some common use of the same habitat. Prey fleas on predators are obvious examples of the first method. The latter routes are not always so easily explained, but widely ranging, ecologically tolerant hosts seemingly would be exposed to the most chances to acquire stray fleas. The absence of such reciprocity between apparently ecologically sympatric host species is also significant and indicates that the hosts lack opportunities for flea transfers to occur or that the alternate hosts are unacceptable.

In western Utah, the deer mouse, *Peromyscus maniculatus sonoriensis*, easily qualifies as the area's most ubiquitous small mammal. It is found in every habitat, has no altitudinal limits, and is sympatric in varying degrees with every small rodent found there. This, combined with its willingness to live in the vacant nests and burrows and travel the runways of other animals, helps explain why the long list of Utah flea records from deer mice (Stark 1958, Parker and Howell 1959, Egoscue 1966) includes so many adventitious species. No attempts have been made in western Utah to measure interspecies flea relationships that compare fleas from deer mice and associated rodents caught at the same time, place, and habitat. My data permit such comparisons of fleas from deer mice and the canyon mouse, *Peromyscus crinitus pergracilis*; desert wood rat, *Neotoma lepida*

lepida; and long-tailed vole, *Microtus longicaudus latus*. Unfortunately, the data do not cover all seasons or the entire altitudinal ranges of the four rodents in the area. Canyon mice were sampled from most of their known altitudinal ranges in the Bonneville Basin (4275-6800 ft.), but a disproportionate amount of the collecting was done near the lower limits.

Unless otherwise mentioned, all localities are in Tooele County. The work was accomplished while I was Research Mammalogist at the University of Utah.

METHODS AND PROCEDURES

Snaptrapping versus livetrapping for ectoparasite studies of small mammals is an ongoing controversy. Each method has its advocates, but I tend to agree with Hopla (1964) that the advantages of snaptrapping can outweigh the disadvantages, especially when traps must be carried long distances over rough terrain. Cant-raps (Scheffer 1934) were used on the wood rat-deer mouse traplines. The rest of the animals were collected with snaptraps. As pointed out by Edwards (1952) and others, the habits of some small mammals make them difficult to snaptrap. I make no claims that my efforts measured the relative abundance of small mammals anywhere, but years of experience teach one where not to place traps; over 95 percent of my sets were equally available to the two hosts compared from each trapline.

A summary data sheet for each trapline, a host catalog, and a flea catalog permitted analysis of flea data from hosts

¹Mammalogist, National Zoological Park, Smithsonian Institution, Washington, D.C. 20009.

according to date, trapline, locality, and community. The data and practically all of the fleas are in my possession. Voucher specimens of mammals from every locality are in the mammal collection at the University of Utah.

RESULTS

I. Deer Mouse - Canyon Mouse

Deer mice and canyon mice were collected at the following six sites listed according to locality, elevation, date, and amount of trapping. Both *Peromyscus* were about equally represented. 1. South end Stansbury Island, 1323.7 m, intermittent trapping, 8 Feb.-13 March 1968. 2. North end Granite Mt., 1464 m, intermittent collecting three days weekly, 28 Oct. 1965-17 March 1966. 3. Little Granite Mt., 1464 m, sporadic collecting between 4 Oct. and 18 Jan. 1966 and 1967. 4. South end Grassy Mts., 1616 m, 28-29 Nov. 1967. 5. Lookout Pass, south end Onaqui Mts., 1921 m, 8 Oct. 1967. 6. Dry Canyon, west side Oquirrh Mts., 1975 m, 26 Sept.-2 Oct. 1968.

Habitat features favoring the presence of canyon mice such as cliffs, ledges, and boulder-strewn hillsides occurred at all

locations. Locality No. 6 approached the known upper altitudinal limits for *P. crinitus* at this latitude in Utah (Egoscue 1964) and was the most mesic in terms of plant species.

Fleas from the deer mouse - canyon mouse sampling are presented in Table 1. Of the 96 *P. crinitus*, 77 (80.2 percent) were infested with a total of 285 fleas for an average of 3.7 (range 1-12) per infestation. Sixty (66 $\frac{2}{3}$ percent) of the 90 *P. maniculatus* carried 207 fleas for a 3.45 average (range 1-17) per infested host.

Nineteen species of fleas were found, of which 13 occurred on deer mice and 15 on canyon mice. Nine kinds of fleas were shared. The data clearly establishes *P. crinitus* as a primary host of *Malareus sinomus* and *Stenistomera macrodactyla*, and *P. maniculatus* as a primary host of *Monopsyllus wagneri* and *Opisodasys keeni*, even though much of the collecting was done in habitat ecologically unsuitable for the last. Seventeen (18.9 percent) of the deer mice were infested with canyon mouse fleas, and twenty (20.8 percent) of the canyon mice carried deer mouse fleas. Too few specimens of some rare fleas such as *C. terinus* were collected to clearly establish host preferences, but

TABLE 1. Comparison of fleas from deer mice and canyon mice collected from the same traplines in western Utah.

Flea species	Total no. collected	Deer mouse fleas		Canyon mouse fleas		Primary host(s) in area
		No. collected	%	No. collected	%	
1. <i>Athyphloceras echis</i>	2	2	100	0	—	<i>Neotoma</i> sp. (nest flea)
2. <i>Rhadinopsylla sectilis</i>	2	0	—	2	100	<i>Peromyscus</i> sp.
3. <i>Carteretta clavata</i>	1	0	—	1	100	<i>Perognathus formosus</i>
4. <i>Meringis dipodomys</i>	6	4	66.6	2	33.3	<i>Dipodomys microps</i>
5. <i>M. parkeri</i>	1	0	—	1	100	<i>D. ordii</i>
6. <i>M. hubbardi</i>	4	2	50.0	2	50.0	<i>Perognathus parvus</i>
7. <i>Eptedia standordi</i>	4	4	100	0	—	<i>Peromyscus maniculatus</i>
8. <i>Callistopsylla terinus</i>	7	1	14.3	6	85.7	<i>Peromyscus</i> sp.
9. <i>Megarhroglossus</i> sp.	3	2	66.6	1	33.3	<i>Neotoma</i> sp. (nest flea)
10. <i>Stenistomera alpina</i>	7	0	—	7	100	<i>Neotoma</i> sp.
11. <i>S. macrodactyla</i>	42	0	—	42	100	<i>Peromyscus crinitus</i>
12. <i>Anomiopsylla amphibolus</i>	1	0	—	1	100	<i>Neotoma</i> sp. (nest flea)
13. <i>Peromyscopsylla selensis</i>	1	1	100	0	—	<i>Microtus longicaudus</i>
14. <i>Orchopeas leucopus</i>	25	14	56.0	11	44.0	<i>Peromyscus</i> sp. & <i>Reithrodontomys megalotis</i>
15. <i>O. sexdentatus</i>	8	2	25.0	6	75.0	<i>Neotoma</i> sp.
16. <i>Opisodasys keeni</i>	20	18	90.0	2	10.0	<i>Peromyscus maniculatus</i>
17. <i>Malareus telchinum</i>	5	5	100	0	—	<i>Peromyscus</i> sp.
18. <i>M. sinomus</i>	187	23	12.3	164	87.7	<i>Microtus</i> sp.
19. <i>Monopsyllus wagneri</i>	166	129	77.7	37	22.3	<i>Peromyscus crinitus</i>
Totals	492	207		285		<i>P. maniculatus</i>

I have collected this flea from *P. maniculatus* at places where *P. crinitus* was absent. Holland (1949) listed Canadian records for *C. terinus* that are far beyond the northern limits of *P. crinitus*. The two species of *Malariaeus* were sympatric at only one locality where both *Peromyscus* occurred. Ecologically the area was an ecotone between the xeric habitat of the valley floor and the more mesic mountain-side. Here host preferences were clear; *M. sinomus* occurred almost exclusively on canyon mice while deer mice were the only *Peromyscus* with *M. telchinum* (see also discussion of deer mouse - long-tailed vole fleas). *Orchopeas leucopus*, the fourth most common flea, was found in about equal numbers on both mice.

II. Deer Mouse - Long-tailed Vole

These two rodents were collected together at the 12 places listed according to locality, elevation, and date. 1. West side Johnson Pass, Stansbury Mts., 1827-1903 m, 22 Jan.-4 March 1968. 2. Mouth of Dry Canyon, Oquirrh Mts., 1975 m, 26 Sept.-2 Oct. 1968. 3. East side Simpson Mt., 1982.5 m, 17 Aug. 1965. 4. Indian Springs, Simpson Mt., 1982.5 m, 12-14 May 1964 and 22-23 April 1965. 5. South Willow Creek Canyon, Stansbury Mts., 2074 m, 7 Oct. 1965. 6. East side Indian Park, Needles Range: BEAVER CO., 2104.5 m, 16 Sept. 1963. 7. Ophir Creek, Oquirrh Mts., 2135 m, 31 Aug.-1 Sept. 1966. 8. *Ibid.*, 2165 m, 20 July 1967. 9. Middle Canyon, Oquirrh Mts., 2165 m, 25-26 Aug. 1965. 10. Lookout Mt., Sheep-rock Mts., 2226.5 m, 18-19 May 1966. 11. Indian Peak Summit, Needles Range: BEAVER CO., 2470.5 m, 15 Sept. 1963. 12. Head of Mack Canyon, Stansbury Mts., 2470.5 m, 28 Sept. 1967. 13. North Willow Lake, Stansbury Mts., 2562 m, 17 July 1967.

All traplines except those at localities Nos. 1, 2, 6, and 11 were set along small streams or damp, shaded hillsides adjacent to streams, both of which are preferred *M. longicaudus* habitat types in western Utah. This vole was not restricted to moist areas, however; some were captured in fairly arid situations far from water. I found them only in the mountains and never in concentrations suggesting colonies. More deer mice

than voles were taken at all localities, the ratio averaging about 3.6 to 1.

Fleas from the deer mouse - long-tailed vole sampling are listed in Table 2. Fifty-five (59.8 percent) of the 92 voles had a total of 182 fleas for an average of 3.3 fleas (range 1-21) per infested animal. Of 337 deer mice, 232 (68.8 percent) carried 586 fleas for an average of 2.5 (range 1-25) fleas per infestation. Based on frequency of occurrence, the data established *M. longicaudus* as (1) a primary host of *Peromyscopsylla selenis* and *Megabothris abantis*, (2) a cohost of *Malariaeus telchinum*, and (3) possibly a secondary host of *Catallagia decipiens*. Deer mice were primary hosts of *Epiteidia stanfordi*, *Opisodasys keeni*, *C. decipiens*, *Monopsyllus wagneri* and cohosts of *M. telchinum*. Primary long-tailed vole fleas were found on only nine (3.9 percent) of the infested deer mice, but 37 (67 percent) of the infested voles carried one or more species of primary deer mouse fleas, 88 percent of which were *M. wagneri* and *C. decipiens*. Host preferences of *M. telchinum* were not well defined, at least when both deer mice and long-tailed voles were available. I regard the presence of the two deer mouse "mountain fleas," *E. stanfordi* and *O. keeni* (especially the latter), on *M. longicaudus* as accidental. Judging from the *M. hubbardi* records, deer mice make more contact than long-tailed voles with the Great Basin pocket mouse, *Perognathus parvus*.

Specimens of *Peromyscopsylla hamifer vigenis* were the first collected within the Bonneville Basin, where its true status is still unknown. My specimens (2♂♂ and 2♀♀) came from a *M. longicaudus latus* collected 28 September 1967 at 2470.5 m in the Stansbury Mountains. Very little small mammal collecting has been done at or above this altitude in the isolated ranges within the Basin. Relict populations of *P. h. vigenis* may now be restricted there to the higher elevations by the same geologic and climatic changes that caused discontinuity in the distribution of certain small mammals of the area, such as the water shrew, *Sorex palustris*, and Uinta chipmunk, *Eutamias umbrinus*. (Egoscue 1965). The very few other Utah records of *P. h. vigenis* are from *Microtus* sp. collected in the main Wasatch cordillera (Tipton and Allred 1951).

TABLE 2. Comparison of fleas from deer mice and long-tailed voles from the same traplines in western Utah.

Flea species	Total no. collected	Deer mouse fleas		Long-tailed vole fleas		Primary host(s) in area
		No. collected	%	No. collected	%	
1. <i>Hystrichopsylla dippiei truncata</i>	7	1	14.3	6	85.7	<i>Microtus</i> sp.; <i>Peromyscus</i> sp.
2. <i>H. linsdalei</i>	6	3	50.0	3	50.0	<i>Peromyscus</i> sp.; <i>Microtus</i> sp
3. <i>Atyphloceras echis</i>	1	0	—	1	100.0	<i>Neotoma</i> sp. (nest flea)
4. <i>Rhadinopsylla sectilis</i>	7	5	71.4	2	28.6	<i>Peromyscus</i> sp.
5. <i>Meringis hubbardi</i>	6	6	100	0	—	<i>Perognathus parvus</i>
6. <i>Epitedia standfordi</i>	26	23	88.5	3	11.5	<i>Peromyscus maniculatus</i>
7. <i>Catallagia decipiens</i>	50	37	74.0	13	26.0	<i>Peromyscus</i> sp.; <i>Microtus</i> sp.
8. <i>Megarthroglossus</i> sp.	1	0	—	1	100.0	<i>Neotoma</i> sp. (nest flea)
9. <i>M. procus</i>	1	1	100	0	—	<i>Neotoma</i> sp. (nest flea)
10. <i>Stenistomera alpina</i>	1	1	100	0	—	<i>Neotoma</i> sp.
11. <i>Anomiopsylla amphibolus</i>	2	1	50.0	1	50.0	<i>Neotoma</i> sp. (nest flea)
12. <i>Peromyscopsylla hesperomys adelphia</i>	2	2	100	0	—	<i>Peromyscus maniculatus</i>
13. <i>P. selensis</i>	40	10	25.0	30	75.0	<i>Microtus longicaudus</i>
14. <i>P. hamifer vigens</i>	4	0	—	4	100.0	<i>Microtus</i> sp.
15. <i>Orchopeas leucopus</i>	23	23	100	0	—	<i>Peromyscus</i> sp. & <i>Reithrodontomys megalotis</i>
16. <i>Opisodasys keeni</i>	103	101	98.0	2	2.0	<i>Peromyscus maniculatus</i>
17. <i>Malaraeus telchinum</i>	82	49	59.7	33	40.2	<i>Peromyscus</i> sp. & <i>Microtus</i> sp.
18. <i>M. sinomus</i>	6	4	66.6	2	33.3	<i>Peromyscus crinitus</i>
19. <i>M. euphorbi</i>	4	3	75.0	1	25.0	<i>Peromyscus maniculatus</i>
20. <i>Monopsyllus wagneri</i>	324	300	92.6	24	7.4	<i>Peromyscus maniculatus</i>
21. <i>Megabothris abantis</i>	72	16	22.2	56	77.8	<i>Microtus</i> sp.
Totals	768	586		182		

III. Deer Mouse - Desert Wood Rat

These rodents were trapped together at the following two localities: 1. Granite Mt., 1372.5 m, various dates from 27 Oct. to 1 Dec. 1965 and 13 Jan. to 24 March 1966. 2. North end of Little Granite Mt., 1464 m, various dates from 16 Feb. to 21 Dec. 1966 and 6 to 26 Jan. 1967.

Ideal habitat for wood rats occurred at both places. Most of the deer mice collected probably lived in vegetated areas immediately adjacent to the cliffs, ledges, and rock outcrops favored by *N. lepida*; but some *P. maniculatus* lived in occupied as well as vacant wood rat houses, especially those at the bases of trees. Both localities were near or at the lower altitudinal limits for desert wood rats in this part of Utah and zonally were below the range of most deer mouse "mountain fleas." Both rodents were captured in about equal numbers at each site.

The fleas recovered from these species are listed in Table III. Thirty-three (80.2 percent) of the 47 *P. maniculatus* were infested with a total of 155 fleas for an average of 4.7 fleas (range 1-17) per

infested host. Of 57 *N. lepida*, 52 (91.3 percent) had 403 fleas or 7.75 (range 1-22) per infestation. Reciprocal exchange of primary fleas between deer mice and desert wood rats was less frequent than between canyon mice and desert wood rats. This may reflect the similar ecological parameters of the latter two rodents. Only three (.08 percent) of 386 wood rat fleas came from deer mice, and six (4.5 percent) of 132 deer mouse fleas were found on wood rats, a low reciprocity considering the nearly 1:1 host species ratio and the fact that some deer mice lived in wood rat houses.

The records reaffirm that *N. lepida* is a primary host of *O. sexdentatus*, *S. aplina*, *A. amphibolus*, and *Megarthroglossus* sp. No nests were examined, but other studies have demonstrated conclusively that the latter two species are seasonally more common in *N. lepida* nests than on the hosts (Howell 1955, 1957; and others). About 73 percent of the fleas from deer mice were *M. wagneri*. *Malaraeus sinomus* was the only flea shared to any extent by deer mice and wood rats. While this flea was most commonly found on *P. crinitus* of the area, deer mice may be an accept-

TABLE 3. Comparison of fleas on deer mice and desert wood rats collected from the same trap-lines in western Utah.

Flea species	Total no. collected	Deer mouse fleas		Desert wood rat fleas		Primary host(s) in area
		No. collected	%	No. collected	%	
1. <i>Meringis dipodomys</i>	10	4	40	6	60	<i>Dipodomys microps</i>
2. <i>Epitedia stanfordi</i>	1	1	100.0	—	—	<i>Peromyscus maniculatus</i>
3. <i>Megarathroglossus smiti</i>	8	1	12.5	7	87.5	<i>Neotoma</i> sp. (nest flea)
4. <i>Megarathroglossus</i> sp.	2	0	—	2	100.0	<i>Neotoma</i> sp. (nest flea)
5. <i>Stenistomera alpina</i>	118	0	—	118	100.0	<i>Neotoma</i> sp.
6. <i>Anomiopsylla amphibolus</i>	52	0	—	52	100.0	<i>Neotoma</i> sp. (nest flea)
7. <i>Orchopeas leucopus</i>	18	16	88.9	2	11.1	<i>Peromyscus</i> sp. & <i>Reithrodontomys megalotis</i>
8. <i>O. sexdentatus</i>	206	2	1.0	204	99	<i>Neotoma</i> sp.
9. <i>Malareus sinomus</i>	26	18	69.2	8	30.8	<i>Peromyscus crinitus</i>
10. <i>Monopsyllus wagneri</i>	117	113	96.6	4	3.4	<i>Peromyscus maniculatus</i>
Totals	558	155		403		

able secondary host, particularly in xeric situations. I did not find *M. sinomus* on deer mice from localities where canyon mice were absent.

DISCUSSION

Explanations for the host-flea interrelationships quantified in Tables 1 to 3 can probably be found in Holland's (1958) list of factors responsible for most purposeful and accidental host-flea associations. Strategies evolved by fleas to maintain contacts essential for their survival usually involve the breeding and denning habits of their hosts as well as the ecological requirements and host-finding capabilities of the fleas. Seemingly the most host-specific fleas have the most foolproof methods for insuring these contacts. For example, the tiny, degenerate desert wood rat flea, *A. amphibolus*, may now depend entirely on the predictability of its host's denning habits. Favorite ledges and other den sites within the range of this rodent are often occupied continuously for hundreds or even thousands of years (Wells and Jorgenson 1964) by successive generations of *Neotoma lepida*. Presumably this situation has favored evolution of the almost louselike *Anomiopsyllus* that now has neither the means nor the need to jump and is minus the array of vestiture necessary for most fleas. It is probably not by chance that most, if not all, species of *Anomiopsyllus* are hosted by mammals (mainly *Neotoma* sp.) that repeatedly use the same den sites. I regard the presence of *A. amphibolus* on rodents other

than wood rats as purely accidental and almost certain evidence that these hosts had visited or lived in wood rat dens.

The significance of these and other accidental host-flea contacts is difficult to assess. At the very least they provide fleas a short reprieve. They assume epidemiological importance only when the fleas and/or hosts carry disease and the fleas are capable vectors willing to feed. Host specificity and the potential importance of secondary and other host categories to fleas are discussed by Wenzel and Tipton (1966).

The deer mouse and its fleas provide unlimited possibilities for the study of flea ecology, the effects of past geologic events of present flea distribution, host specificity, and many other aspects of host-parasite relationships.

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